NOTES ON THE GEOLOGY AND PHYSIOGRAPHY OF ALBANY.

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(With Five Plates and Two Text Figures.)

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INTRODUCTION.

The town of Albany is situated on the northern side of Princess Royal Harbour. This harbour is an almost completely land-locked body of water about five miles long from north-west to south-east, and about two and a half miles in width, which at its eastern end connects with King George's Sound by a narrow channel. Much of the country surrounding Princess Royal Harbour is of a rugged and broken character, rising into high rounded domes and ridges of granite on the northern side, and into a prominent serrated ridge of granite and the rock known as "coastal limestone" on the southern. This latter ridge separates the waters of the harbour from those of the open ocean. (Pl. I.).

King George's Sound is a large sheet of water almost land-locked on three sides, but open on the east to the ocean. It is connected at its western end with Princess Royal Harbour, and at its north-western corner with the estuary known as Oyster

*By permission of the Director of the Geological Survey of Western Australia.

Harbour. The Sound is bounded on the north chiefly by high steep ridges of granite which plunge sharply into the sea; on the west by the low sand hills of Middleton and other beaches, and by high cliffs of granite; on the south by a precipitous line of granite, flanked by the coastal limestone; and on the east by the ocean, with Michaelmas and Breaksea Islands dividing the entrance into three channels.

Oyster Harbour has an extremely narrow entrance, but opens out to a width of about two miles. Most of it is very shallow, and at low tide, large areas of its bottom are exposed. At its entrance, the opposing sides are strikingly different, that on the west being the end of the low Middleton Beach and sand-cliffs, known as Emu Point, and that on the east being a granite mass 513 feet high, which rises rather abruptly from the water. The western shore of the harbour is either fringed with low-lying silted up ground or with cliffs composed of sedimentary rocks of little height, which bear evidence of marine abrasion. Most of the eastern shore is only a few feet above sea level with low ridges in the near background. The King and Kalgan Rivers enter at the northern end.

Fig. 39.

From the western end of Princess Royal Harbour and stretching at least as far as Torbay Inlet, there is a belt of low-lying

swampy ground parallel to the coast, and occupied in places by small lakes (e.g. Grassmere or Lake Powell, adjacent to the Grassmere railway station). Into this area, which might for convenience be referred to as the "Grassmere Valley," the Seven Mile Creek and Marbellup Brook drain. To the north of Grassmere Valley the country ascends to a low extensive and somewhat dissected plain, which is formed of marine sediments.

We may summarise the chief physical features of the country as follows:—

(1) Swampy land, a few feet only above sea level.

(2) Slightly elevated plains of marine sediments, these plains in the vicinity of Albany being dissected by shallow wide open valleys.

(3) Belts of granite, dissected by streams, with isolated hills and groups of hills of the same rock attaining to various heights up to 700 feet above sea level. Within a short distance outside the area dealt with in this paper, the granite hills attain a height of close upon 2,000 feet or more.

(4) Along the coasts of Princess Royal Harbour and King George's Sound, bold rocky cliffs, which alternate with smooth sandy beaches, behind which lie shallow lakes and swamps with intermediate sand ridges.

(5) The granite and limestone ridge between the harbours mentioned and the open ocean.

GEOLOGY.

The general geology has been described by Mr. A. Gibb Maitland,† Government Geologist of Western Australia (see Bulletin 26 of the Geological Survey), and his map is here reproduced with some slight variations and additions to the geology and some other details which illustrate the physiographic changes discussed in this paper.

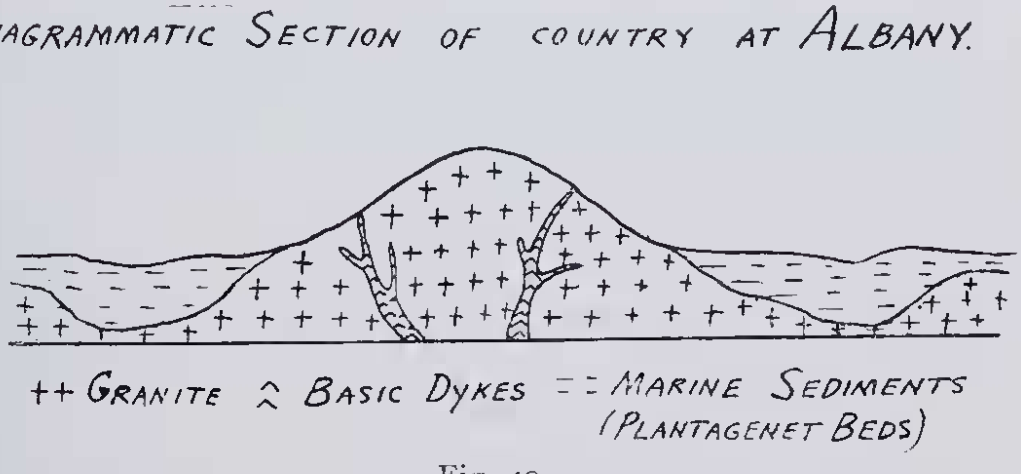

Fig. 40.

†Some earlier references are given by Mr. Maitland, but as they do not affect the main questions here discussed, we do not quote them.

FUNDAMENTAL IGNEOUS COMPLEX.

The fundamental rock is granite which has a wide distribution throughout the Albany district, its chief outcrops forming all the higher ridges and hills, except portions of the Darwin Ridge. It forms the rock of all the islands, and of most of the prominent sea cliffs, as well as constituting the main portion of the Porongorup Range, 20 miles to the north, between Albany and the sedimentary Stirling Range. In the vicinity of Albany the granite varies much in texture from fine to coarse-grained, and is frequently porphyritic. It is traversed by veins of aplite and pegmatite. The granite is essentially composed of quartz, microcline, oligoclase, hornblende and biotite. Its surface contour is most irregular, reaching 1305 feet above sea level at Mount Gardiner, and extending in places beneath the marine sediments to some depth below the ocean level. It has suffered enormous erosion prior to the deposition of the Plantagenet Beds described later, and further denudation since their formation.

Intrusive into the granite are numerous basic dykes (dolerite and basalt) which range in width from less than an inch to many yards. These dykes may be seen on many of the bare granite hills penetrating the granite with remarkable clearness, rivalling in this respect the diagrams of text books. At the brick pit about three miles to the north-west of Albany, a decomposed basic dyke cuts through not only the granite, but also the over-lying marine sediments. This evidently belongs to a later series of basic dykes than many of those intrusive into the granite, and may possibly be related to the basalts of which those at Bunbury are the type.

PLANTAGENET BEDS.

In the hollows of the granite the marine series of sediments already referred to, rest. These beds, the deposition of which has largely levelled the country, the authors propose to name the "Plantagenet Beds," in view of their wide distribution throughout the Plantagenet district. They extend at least from Torbay (to the west of Albany) as far eastward as the Phillips River, and northward to the southern side of the Stirling Range. The only localities where they have been studied in any detail are Albany, Warriup (about 35 miles north-east of Albany) and Cape Riche, though characteristic fossils have been collected at many other points. The rocks at Albany are well shown in the brick pit mentioned above. They consist of a silt at times cemented into a fine-grained sandstone, and they still retain practically their horizontal position, showing that although the land has since their formation been relatively elevated and depressed, scarcely any disturbance of the rocks has occurred. Siliceous sponges are especially abundant throughout these beds, many complete skeletons of lithistids being obtainable, whilst isolated spicules of the same

and of tetractinellids form an important proportion of the whole rock. In addition, gasteropods, cephalopods, lamellibranchs, and echinoids are found, but unfortunately they are, as a rule, too poorly preserved for specific determination, though an extensive collection might enable the species of some forms to be ascertained.

Lithologically these beds are characterised by—

(1) Their uniformly fine grain.

(2) The comparatively small proportion of kaolin present.

(3) The almost total absence of calcium or magnesium carbonates.

(4) The large proportion of purely siliceous material present (quartz and opal).

(5) The fact that siliceous (opal) sponge spicules form an appreciable, at times a preponderating, part of the whole mass.

(6) The usual slight coherence of the particles to one another.

The following are analyses‡ of two coherent sandstones belonging to this series from Cape Riche:—

	White Stone.	Yellow Stone.
SiO_2 sol. in 5 % NaOH	60 22	82·58
SiO_2 insol. „ „	23.40	
Al_2O_3	6.25	5 95
Fe_2O_3	1·95	2·34
MgO...	57	·39
CaO	·13	*nil*
H_2O above 100°	2 74	2·82
H_2O at 100°	3·50	3·49
Alkalis and loss	1·24	2·43
	100·00	100·00
Bulk specific gravity	1·33	1·44
True specific gravity	2.18	2·20

In consequence of having been laid down upon a very irregular surface of granite the thickness of the Plantagenet Beds must be variable, in some places being very thin and probably nowhere exceeding 300 feet. Their exact age is undetermined, but from the frequently unconsolidated nature of the materials, their approximately horizontal stratification, and the modern appearance of the contained fauna, the sediments cannot be very ancient. Fossils from various localities have at times been examined by Mr.

‡ By E.S.S.

Robert Etheridge, of the Australian Museum, Sydney, but on account of their poor state of preservation, he has been unable to state their age more definitely than (taking the substance of his statements for various localities in unpublished letters to the Geological Survey of Western Australia) as "either recent or young Tertiary."*

On the other hand the most definite evidence in regard to the age of the Plantagenet Series is afforded by the fossil *Aturia australis* (McCoy), a cephalopod, having in Victoria, according to McCoy††, and Chapman‡‡, a range from Oligocene to Lower Pliocene. One specimen of this was determined some years ago by R. Etheridge, Junior, in material from Cape Riche, and a second quite recently by L. Glauert in undoubted spicular silt of the Plantagenet Series from the Bremer River**, 100 miles north-east of Albany. In view of the occurrence of this fossil, and of the known extensive submergence of Southern Australia during Miocene times, the authors believe that the Plantagenet series will ultimately be determined as of Miocene age.

From a physiographic and geological point of view, it is very necessary that a detailed examination should be made of the fossils contained in these widespread deposits. The same remarks apply to other fossiliferous rocks of comparatively late age in the southern portion of this State (e.g., those at Lake Cowan) which may ultimately be correlated with the Plantagenet Series.

LATER FORMATIONS.

The rock known as the "Coastal Limestone" occurs on portions of the crest and slopes facing the ocean of the high ridge between Princess Royal Harbour and King George's Sound on the north, and the Southern Ocean on the south, to which reference has already been made. Charles Darwin, during the famous voyage of the "Beagle" landed near Bald Head and made various observations there. As the ridge referred to bears no distinctive name, we propose to term it the "Darwin Ridge," in honour of the great naturalist who first studied its structure. The coastal limestone may be observed covering and plastering over the granite, which from its numerous outcrops at all heights from sea-level to crest may be regarded as the back bone of the ridge. Mr. Maitland has described this limestone and considers it to be of aeolian origin, a conclusion reached independently by the authors, who have observed that it is composed mainly of foraminifera and fragments of calcareous algae, which have been blown into their present

*See Bulletin 26 of the Geological Survey of Western Australia, p. 60.

††Palaeotology of Victoria, Decade III., Pl. xxiv., pp. 21, 22.

‡‡ "Australasian Fossils," 1914, p. 210.

** Bremer River runs into Bremer Bay.

positions by the prevailing winds. The rock represents in their opinion, old sand dunes that have been in large part consolidated.

Owing to the variability in composition from place to place, the whole of the sands of these old dunes have not been consolidated into the hard coastal limestone, although the latter rock outcrops so widely that in mapping the country fairly definite boundaries must be given to the area in which the limestone predominates, and in this way it must be saparated from those other dunes which appear so far to have entirely escaped consolidation, or almost so.

This irregularity of conversion of the dunes into limestone is rather to be expected than to be wondered at, when the process of consolidation, namely, the solution from the sands themselves and the redeposition of carbonate of lime, and the different characters of the sands, which are partly calcareous and partly almost wholly siliceous, are considered. The process may be regarded as a more or less continuous one from the time of its commencement to the present day, and it is still going on. Concurrently with this consolidating process, the limestone is being reduced again to sand by atmospheric agencies, and these two antagonistic forces have no doubt been at work from the time when consolidation first commenced, which would probably soon follow the formation of the dunes.

There is no definite evidence as to the age of the older dunes, but judging from their distribution they were formed subsequent to the deposition, and uplift of the Plantagent marine beds.

The remaining rocks of the district belong to the recent period and comprise the sands of the present forming dunes of the coast and of the beaches and bars of the present seas, together with the fine silt (including diatomaceous earth of Grassmere and elsewhere) now filling the lakes and swamps of the low-lying portions of the district. They need not be further mentioned here.

PHYSIOGRAPHY.

RECENT DISPLACEMENTS OF THE STRAND LINE.

There is evidence in the Albany district of three comparatively recent—geologically speaking—displacements of the strand line. The first (positive) of these three is that of the submergence of the old eroded granite land surface, upon which the Plantagenet marine beds rest. As those beds now form a wide-spread plain of marine sedimentation, the ocean, on the displacement referred to, must have stretched as far north as the Stirling Range, and also to the east and west of Albany, the eastward extension covering

many miles. The Plantagenet beds near Albany rise to a height of 170 to 200 feet or more above sea-level, but their maximum thickness is not known. The depth of the Plantagenet Sea has not been determined, but as the present hills and ridges of granite rise high above the existing plain of marine sedimentation---and were thus not submerged—and the organisms contained in the strata do not appear to be of very deep-water origin, the depth of the sea was probably not more than a few hundred feet. The summits of the old granite hills and ridges would thus at that time have formed a group of islands and islets, at no great distance from the coast, being in this respect a close counter-part to the present Recherche Archipelago, some distance to the east of Albany. There is also no evidence at present available to determine the height of the old land surface prior to submergence.

The second displacement was a negative one, the old sea-bed in the neighbourhood of Albany attaining a height of more than 200 feet above sea-level. This fact is indicated by the present height of the plain of marine sedimentation, which however, does not measure more than a minimum amount of displacement, as a positive movement has since taken place. Between the time of the latter and the negative displacement, the land must have occupied a much greater area than at present. Judging by the channels forming the various entrances to King George's Sound, the land probably extended at least as far east and south as these entrances, and perhaps also considerably to the south of the present ocean coast line west of Bald Head.

The third displacement was the positive movement just referred to, which resulted in the drowning of the lower end of the old King-Kalgan River, and the formation of Oyster and Princess Royal Harbours and King George's Sound (the latter two possibly however, forming at first portion of a strait extending to the present Torbay Inlet). These points will be later discussed and the evidence stated to show that on this displacement, the sea covered somewhat more land than at present. To the north of Albany the depth of the sea caused by this movement might only have been a comparatively few feet (as the partially drowned valleys of the present King and Kalgan Rivers have not very deep water), but if the old land extended eastward from Limestone Head, in the latter locality, assuming no change in depth has since taken place, it would be more than 150 feet, as the sea there is now a greater depth than this. It is quite possible that the 30 fathom line was about the boundary of the old land.

There may have been a later negative movement, but the writers are not aware of any definite evidence as to this, although it has been noticed in many parts of the Australian coast. If however, it is taking place, it will hasten the reclamation of the land.

THE DROWNED VALLEYS AND PLAINS.

That the land has been comparatively reeently submerged (thc third displacemcnt above deseribed) is at once suggested by the huge rounded masses of granite that rise boldly from the sea; by the irregular naturc of mueh of the coast line; by the various sea channels; and by the full appearance of the rivers.

Amongst the granite outcrops are the islands known as Breaksea, Michaelmas, Mistaken and Seal. These are either at the entrance to or within King George's Sound. On the mainland, the high and steep hills known as Mounts Melville, Clarenee and Adelaide, rise sharply from the sea, and the same remark applies to the granite mass opposite Emu Point at the mouth of Oyster Harbour. Limestone Head at the southern entranee to King George's Sound also shows a bold outline. It evidently eonsists of granite, coated with coastal limestone.

The irregular nature of much of the coast line is shown by the large harbours frequently referred to in this paper, as well as by the smaller indentations to the east and to thc west.

The various sea ehannels inelude the channel between Eclipse Island and the mainland, the three entrances to King George's Sound, and the entrances to Princess Royal and Oyster Harbours. The former harbour (Princess Royal) originally apparently had three entranees, but the two southern ones have disappeared, owing to eauses which are subsequently stated.

The peculiar full appearanee so indicative of drownеd valleys is very well shown in the lower portions of both thc King and the Kalgan Rivers, the valleys of these streams in such portions eontaining far more water than they would if they aeted merely as drainage ehannels for the ordinary rain waters falling within their respeetive basins. (Pl. II., Figs. 1 and 2).

These facts are therefore taken to be conclusive evidenee of the recent drowning of the lower portions of thc valleys and of the plains on whieh the rivers formerly meandered. Thus the King and Kalgan Rivers were, prior to this drowning, united below their present mouths into one stream, whieh made its way over the land now covered by the waters of Oyster Harbour and King George's Sound, and apparently passed through the noteh that now forms the south channel of the Sound. By this submergence the rivers were betrunked and the three large harbours (Oyster, Prineess Royal, and King George's Sound) were brought into existenee, with probably however, at first an extension of the sea through to Torbay Inlet, with the long east and west Darwin Ridge as an island. Since drowning, various ehanges have taken place which have redueed the sea area, as will be shown in a later section.

It may be noted that three ehannels form the entranees to King George's Sound, and three channels (having the same east and

west direction as, but narrower than those of the Sound)*, apparently formerly existed as the entrances to Princess Royal Harbour.** So far as the Sound channels are concerned, we have suggested above that the old united King-Kalgan River probably passed through the south channel, and thus the latter becomes intelligible, but the origin of the Princess Royal channels is not clear, as no present stream can be suggested as having occupied any one of those channels prior to submergence.

Both on the mainland and island coasts of the harbours, cliffs appear to have been little cut by the sea, thus apparently emphasising the comparatively recent drowning of the land: but in this connexion, it must be remembered that the mode of weathering of the granite into rounded masses by exfoliation, would tend to keep the cliffs relatively low by the constant slipping into the sea of the large onion-like flakes of rocks above the sea-cut cliffs, thereby reducing the height of the latter.

On the ocean coast between Bald Head and Torbay Inlet, the cliffs are high and steep, and the coast line, despite certain promontories of granite, is on the whole very regular and unindented, suggesting strongly that marine abrasion has been at work for a considerable peirod of time. The nature and structure of the rocks must however, as regards this point, be taken into consideration. As already indicated, the surface rocks of the Darwin Ridge are the coastal limestones, plastering and covering over, as consolidated sand dunes, the old granite. The action of the wind in building up sand dunes along a coast almost invariably smooths the outline of that coast, and hence it may be concluded that the present form of the coast in question is due to this cause. This land must however, in the absence of direct evidence to the contrary, be regarded as having taken part in the depression which caused the drowning of the valleys and plains, and consequently the coast line must have extended farther south. This raises the question as to when the sands which now form the limestone were built up. If we regard them (and therefore the resulting limestone) as of later occurrence than the drowning of the valleys, that is a sufficient explanation of the present contour of the coast; but the limestone, as limestone, although it is still forming as shown above, certainly appears for the most part to be older than the loose sands which form the various bars about the large harbours, and which represent the deposits since the last known submergence. The formation in large part of the limestone may therefore probably be regarded as prior to such submergence, although the point cannot at present

*In addition to the agreement in number and direction between the two sets of channels, the most southerly of the three is in each case, the widest.

**The causes of the disappearance of two of these channels are later stated.

be definitely proved. On this hypothesis, the coast has probably sustained considerable marine abrasion, which largely accounts for its present even outline, such abrasion being assisted by the great strength of the waves on this outer exposed coast, and the absence of any protecting sand bars.

BUILDING OF SAND BARS AND THE GROWTH OF THE LAND SINCE THE LATEST SUBMERGENCE.

That sand bars have been extensively built in various places, is evident on a very casual examination, and likewise that, largely owing to such building, the sea has been silted up into land, with the formation of temporary lagoons and lakes, and the tying of islands to the mainland and to one another.

An excellent example of a long sand bar is the well-known Middleton Beach, at the north-western end of King George's Sound. This beach is about three miles long, and stretches north-easterly from Mr. Adelaide to Emu Point. The sea was originally about a mile farther west, stretching south-westwards from Bayonet Head to Strawberry Hill, and thence south-eastwards to Mt. Adelaide; but the intermediate area, owing to the exceptional facilities provided by the sand bar, has now almost all silted up, although still swampy and possessing one main sheet of water, Lake Seppings. The building of the Middleton bar has reduced the mouth of Oyster Harbour to its present narrow dimensions, and by such reduction, the silting up of the bay just mentioned has been much facilitated. It is the formation of this bar that has caused the Middleton Beach to be such an excellent bathing spot.

Other sand bars—behind which are swamps and lagoons—have been recently built to the east of Albany.

An illustration of the building of the particular form of sand bar known as a "tombolo," which results in the tying of islands, is shown in the narrow peninsula running north from Frenchman Bay to the entrance of Princess Royal Harbour. This strip of land consists of two low sandy areas, connecting two higher belts of granite with the main mass of the latter to the south. On the King George's Sound side, the sandy portions are bounded by low cliffs of sand, whilst on the Princess Royal Harbour side the sand slopes gently to the sea. The difference is due partly to the rougher sea of the outer harbour compared with that of the inner, the former tending to build the sand into banks, and partly to the action of the wind in blowing the sand over into the smoother water of the inner harbour. The granite hills of the peninsula are apparently old islands now tied to one another and to the southern mainland by the sand bars just mentioned. The result has been to reduce the number of entrances to the Princess Royal Harbour from three to one, and to give greater play to that bay for silting up. The acceleration of the latter will be understood when it is

noted that the present entrance is but a little over a quarter of a mile wide, while the more southerly of the two old channels was over a mile in width.

If, as seems probable, the sea on the latest submergence stretched as a strait from King George's Sound to Torbay Inlet with Darwin Ridge as an island, such strait (which might for convenience be referred to as the "Grassmere Strait") has since been largely silted up, and has now become the Grassmere Valley, with the lakes, such as Grassmere or Lake Powell and others, as temporary phases in the growth of the land. The conversion of water into dry land has been considerably assisted in this area by the formation in the beds of fresh water lakes of thick deposits of diatom frustules. By this means Grassmere has been plainly reduced to one half its earlier extent, what was formerly the southern half of the lake being now occupied by a dry bed of diatomaceous earth at least six feet thick.

None of the three channels forming the entrance to King George's Sound has yet been converted into dry land, but the Admiralty charts show that there is a shallowing of the channel (the North Channel) between the mainland and Michaelmas Island, which if continued will result in the tying of the island to the mainland.

The mouths of Oyster and Princess Royal Harbours still remain open. In the former case, the flow of water from the King and Kalgan Rivers, together with the tide, may be responsible for this, but in the latter case, although the tide probably has some influence, dredging has to be continuously practised to keep an open waterway of the necessary depth.

One of the general results of the building of the sand bars is to facilitate silting and consequently to rapidly increase the area of land reclaimed from the sea, the materials forming the new land being the detritus brought down by the rivers and creeks and the sands carried by tides, currents or winds into the silting area. As this silting up progresses, and assuming no deformation, Oyster Harbour, amongst other changes, will disappear, and its place will be taken by low swampy land, through which the King and Kalgan Rivers will meander, but as one river, the two having become engrafted by the reclamation of the land.

Another result is the smoothing of the coast line which lies to the east of Albany, where immediately following the latest submergence, the coast was more broken and irregular than the present one.

By the process of natural reclamation here outlined, swampy land is formed, which on being drained, is well suited to the growth of various agricultural products.

GENERAL ROCK WEATHERING.

Some brief remarks may be made on this point. The principal hard rocks of the district are the granite and the coastal limestone. They present a clear contrast, the former being carved into rounded forms, and the latter into serrated ridges and sharp points.

The effect of the spheroidal weathering of the granite on a great scale as tending to keep the marine-cut cliffs low, has been noticed above. Another point is that these spheroidal coats slip at times from higher to lower levels on the land, and so form landslips of which abundant evidence exists at Albany. These landslips cause a danger that must be safeguarded against as residences encroach on to the higher portion of Mt. Clarence. The vegetation is of course removed with the rock mass on a landslip, leaving a bare and frequently steep surface. Rain falling upon this surface, washes away the soil and debris as fast as formed, and thus many of the granite slopes are destitute of plant life. A striking instance of this feature is the bald, smooth mass of granite forming the southern end of Mt. Melville.

The general weathering of the granite is also influenced by the numerous basic dykes of two distinct types, by the pegmatite veins, and by the very marked variations in texture and composition of the granite itself.

The sharp and serrated mode of weathering of the coastal limestone has been already referred to. On the ocean side between Skull Head and Cave Point, the limestone has a high dip toward the sea. This assists the slipping of the rocks from the cliff face, when the latter is undermined by marine abrasion.

In connection with the weathering of the coastal limestone, reference may here be made to the fine examples of casts of roots, stems, and branches of shrubs and trees in carbonate of lime dissolved out of the limestone, vide Plate III., Figs. 1 and 2. Apart from its own intrinsic interest, this phenomenon will always possess a great historic value to Australian natural history students, by reason of Charles Darwin having very fully described it. To that admirable account nothing need be here added.

OTHER FEATURES.

The Albany district is rich in physiographic interest. Beside the phenomena described in this paper, there are possible wave-cut terraces, various plains of erosion (indicated by the granite masses at various levels) and residuals on such plains. The writers have however, not sufficient evidence to justify at present any account of these interesting occurrences.

SUMMARY.

The Albany district possesses a much indented coast line with precipitous cliffs of granite and less frequently of limestone, both

on the islands and mainland, alternating with smooth sandy beaches. The land features are diversified, the various forms comprising prominent hills and ridges, a low somewhat dissected plateau of marine sediments, a high coastal ridge of granite partly covered with the coastal limestone, and low swampy ground at the heads of the harbours and behind the recent sand bars. The picturesque King and Kalgan Rivers are the two main streams of the area, the other streams being small and comparatively insignificant.

A study of the geology reveals granite as the fundamental rock intersected by pegmatite veins and dolerite and basaltic dykes. In the eroded hollows of the granite lie an extensive series of marine beds known as the Plantagenet beds (which are probably of Miocene age); and along the ocean coast, old sand dunes which originally spread over the old granite ridge there have been largely consolidated to form the coastal limestone. The most recent deposits include the superficial fluviatile and lacustrine silts, sands and infusorial earths, together with the sands of the various sand bars and of the present-forming dunes.

At least three geologically recent displacements of the strand line have taken place, the earliest of these being the submergence following which the Plantagenet marine beds were deposited. The second resulted in the uplift of the land upon which the King and Kalgan Rivers and other streams carved out their channels. The third movement drowned the lower ends of the valleys and the adjacent land. As a result of this movement the sea may have extended as a strait from King George's Sound to Torbay Inlet.

Since the last definitely known (positive) movement, land has been naturally reclaimed from the sea by silting up, the latter being hastened by the formation of lines of sand bars. The most prominent of these bars is that which has produced Middleton Beach. By such silting and building of bars, some old islands have been tied to the mainland

The granite weathers into prominent rounded masses, and the coastal limestone into serrated ridges. Landslips occur on the granite hills.

The writers are indebted to their colleague, Mr. H. P. Woodward for various information relating to the Albany district.